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ABSTRACT

A job analysis to determine the technical functions of the job of mechanic in a utility company resulted in a Technical Competence Specification (TCS). The TCS identified the significant knowledge and skills organized into content domains. A content-related validation procedure determined the relevance of the mechanic training program content and ascertained the validity of post-training tests. The five training courses in the program were content analyzed by reviewing lesson plans and other instructional materials to produce a preliminary inventory of training elements for each course. Subject-matter experts (SMEs) rated each training element in the Training Program Content Inventory according to its job relevance. A content validity ratio (CVR) for each training inventory element resulted. The average of these ratings was computed as an overall content validity index for the inventory, for each course individually, and for each course module or topic area. In a manner parallel to the determination of course content relevance, SMEs linked each post-training test item to a TCS number and then applied the Lawshe rating procedure. The analysis of the training coverage showed that the curriculum well represented the important aspects of the job. CVRs indicated that test item reconstruction was warranted. (YLB)

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CONTENT - RELATED VALIDATION TECHNIQUES APPLIED TO TRAINING EVALUATION

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Content-related Validation Techniques Applied to

Training Evaluation

ABSTRACT

Increased emphasis on productivity improvement in technology-based organizations has resulted in the creation of numerous technical training programs, with post-training tests being used for both selection/promotion and training needs analysis. The present study details a useful technique for determining the content-related validity for both technical training courses and post-training tests.

INTRODUCTION

As technical training programs become more widespread, the need for objective procedures for evaluating the job relatedness of these programs is evident. When satisfactory completion of training programs is required for entry into or advancement within a job progression sequence, validation of the post-training tests is accepted practice (APA, 1985). However, evaluation of the training content itself is typically neglected.

One exception to this state of affairs is a study by Ford & Wroten (1984). Using an innovative approach to training course evaluation, these authors applied procedures recommended by Lawshe (1975) to derive content validity ratios (CVRs) for each course element and an overall content validity index (CVI) for the course. A matching procedure linking course content to training needs was then applied to determine representativeness.

These procedures and others, (Bownas, et. al. 1985; Faley & Sundstrom, 1985) however, do not include the means for comparing course content relevance with test content relevance. This distinction is important, since some form of post-training test rather than course content, per se, is typically used as the basis for making selection and/or advancement decisions.

The present study first presents the results of a job analysis to determine the technical functions of the job of Mechanic in a utility company. The end result of this analysis is a Technical Competence Specification (TCS), which identifies the significant knowledges and skills organized into

content domains. This document is compared to an exhaustive training content inventory, with training elements categorized according to the same content domains. In addition, each course element is linked to a specific Technical Competence Specification element, and domain weights are then compared to determine whether the training is representative of the job.

A content-related validation procedure is then used to determine the relevance of the Mechanic training program content and to ascertain the validity of post-training tests. The training program in this study includes five courses in the following areas: general mechanic work, electrical fundamentals, millwright work, machine shop, and welding. Since passing each course is required for advancement through the various Mechanic progression steps, validation of the selection procedures is essential for compliance with EEOC Guidelines (EEOC, 1978).

Determination of the job relevance of the training courses themselves is intended to provide recommendations concerning training curricula, including degree of emphasis to give specific content areas. Although the courses themselves are not selection instruments, they can be considered to be part of the overall selection procedure and any improvements in their job relevance should also increase the likelihood that the training will improve job performance.

It should be noted that the techniques described in this paper do not directly analyze training needs or demonstrate the effectiveness of the training in terms of changed attitudes or behavior on the job. (Obviously many other factors such as instructor skill, availability of practice

materials, and amount of training time allotted will contribute to these training outcomes.) Rather, the focus of this training evaluation procedure is to provide a technique for determining the representativeness and job relevance of both training program content and post-training tests.

METHOD

Technical Function Analysis

Audit interviews were conducted with a sample of incumbents in the Mechanic classification to determine the technical knowledges and skills required on the job. This information was supplemented by discussions with subject matter experts (SMEs) and review of job materials (e.g., written procedures job descriptions, etc.) to produce a preliminary listing of technical knowledges and skills. The elements of this listing were rated by incumbents using a 0-7 rating scale based on the Hemphill (1959) part-of-the-job response format. Those items rated significant by incumbents were then categorized by SMEs according to time learned (i.e., prerequisite for job entry vs. time learned on the job). The final product of this step was a Technical Competence Specification (TCS), reflecting the knowledges and skills required of a Mechanic at each step in the progression sequence.

Construction of Course Content Inventory

The five training courses were content analyzed by reviewing lesson plans and other instructional materials to produce a preliminary inventory of training elements for each course. After review by instructors, the individual inventories were combined into one overall Training Program Content Inventory for the Mechanic curriculum. This inventory utilized the same content domains contained in the TCS.

Determination of Course Content Relevance

To provide empirical support for the relevance of the training program in general and the five training courses in particular, the SMEs rated each training element in the Training Program Content Inventory according to its job relevance.

The relevance ratings involved first assigning a TCS statement number to each course content element. If a training element could not be linked to a TCS number, it was considered not relevant to the job and was not rated further. Those training elements which were assigned TCS numbers were then also rated according to Lawshe's (1975) three point scale as to their impact on job performance.

The above procedure resulted in a content validity ratio for each training inventory element. The average of these ratings was computed as an overall content validity index for the inventory as a whole, for each course individually, and for each course module, or topic area.

Validation of Post-training Tests

In a manner parallel to the determination of course content relevance, SMEs linked each post-training test item to a TCS number and then applied the Lawshe (1975) rating procedures. Both multiple choice written examinations and hands-on performance exercises were evaluated using the Lawshe technique.

Determination of Representativeness

Weights for each job content domain in the TCS were computed based on the number of statements in a domain relative to the total number of TCS statements. Course content weights were determined based on the number of course content elements linked to a TCS domain relative to the total number of course inventory elements. Course content domain weights and job content domain weights were then compared in tabular form and discrepancies were investigated further.

RESULTS

Course Relevance

Content validity ratios (CVRs) for the training content inventory elements, based on the ratings of 13 SMEs, ranged from -.33 to 1.00. It was recommended that those elements with a CVR below .20 be omitted from the training syllabi, or included on an optional basis for course participants, but that those topics not be included in the post-training tests.

The total course content inventory yielded a mean CVI of .64 for the training program overall. This level is statistically significant ($p < .05$), indicating that the training content is highly relevant to the Mechanic job. With the recommended content element omissions, the CVI for the program is .73.

Table 1 depicts the CVIs for the training program as a whole and for the individual courses. Table 2 shows an example of a more detailed analysis of an individual course including CVIs for content domains as they are now taught and for the recommended syllabi (excluding course elements with CVRs below .20).

Post-training Test Validity

Content validity ratios for the post-training test items ranged from -1.00 to 1.00, and were based on the ratings of from four to five SMEs for each test.

It was recommended that test items with CVRs below .20 be omitted from the tests or revised and re-evaluated for relevance.

As shown in Table 1, the CVIs for the post-training tests ranged from -.28 to 1.00, yielding a mean CVI for the test battery of .26. This statistic is indicative of a rather low level of job relevance for these instruments. However, when test items with CVRs below .20 were omitted from the calculations, the overall battery CVI rose to .62. Table 3 shows a detailed analysis of the validity results for one test.

In general, the CVIs for the courses were higher than those for the tests, indicating some difficulty in item construction. Written test items also showed lower CVRs than performance items, again supporting the conclusion that difficulties in writing multiple choice items contributed to the relatively low written exercise CVIs.

Representativeness of Course Content

Table 4 shows the comparison of domain weights for job content and for training content. Of the 13 domains, six showed sizable discrepancies in job vs. training emphasis (discrepancy greater than 5% in the positive or negative direction). These areas were reviewed to determine the reasons for the discrepancies. For example, although the welding and electrical domains appear overrepresented in training, these areas were determined to be associated with more technical areas of the job in which intensive training is most needed. On the other hand, the tools domain, although it appears underrepresented in training, was considered more amenable to

on-the-job training because of its less technical nature. Increased training emphasis was considered warranted, however, in the areas of safety and measurement.

Overall, the analysis of the training coverage indicated that the curriculum well represents the important aspects of the job. In addition, the program emphasizes the more technical knowledges and skills required in the job, in effect providing training in areas which would benefit most from a classroom approach.

Discussion

This technique provides an efficient means of determining the representativeness of training coverage and for determining the relevance of both the training content and the post-training tests. Use of the Lawshe (1975) procedure provides test validity evidence as well as a meaningful analysis of the job relevance of training content. Linking the training content directly to a separate job analysis document also provides a straightforward means of comparing training and job emphasis.

Although the end-of-training tests are the actual selection instruments used for incumbents in the Mechanic job progression described here, merely validating the post-training tests would provide limited information as to the effectiveness of the training program. In this study, for example, the CVIs for post-training tests were much lower than those for the training courses. By reviewing the test CVIs alone, this training program might

have undergone expensive, and unfounded, revision, when a reconstruction of the written test items was sufficient intervention.

As technical training programs continue to expand, their expense must be justified in terms of their cost effectiveness and contribution to improved productivity. By analyzing the course content in the manner described above, quantitative results can be used to determine training program emphasis. By eliminating non-relevant training hours and focusing training on those job domains best addressed in a classroom setting, training budgets can be stretched through more efficient use of classroom hours.

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Table 1

Summary of Course Content and Test Battery
Content Validity Indices

Course Title	Course Content Validity Index	Test Name	Test Content Validity Index
General Mechanic	.71	Written Exercise	.55
		Skill Performance	.62
Welding	.87	Written Exercise	.30
		Skill Performance	.40
Millwright	.63	Written Exercise	.16
		Skill Performance	.27
Machine Shop	.55	Written Exercise	-.24
		Skill Performance	-.17
Electrical	.43	Written Exericse	.17
		Skill Performance	1.00

Table 2

Content Validity Indices for General Mechanic Course
Content Sections for Present and Recommended Syllabi

Course Section	Content Validity Index	
	Present Syllabus	Recommended Syllabus
Shop Math	.91	.91
Precision and Coarse Measurement	.60	.60
Basic Hand Tools	.99	.99
Machine Shop Work	.97	.97
Pipe Fitting	.91	.99
Millwright Work	.53	.72
Rigging and Hoisting	.83	.83
General Mechanic Course - overall	.71	.82

Table 3

Content Validity Ratios for General Mechanic Course Skill Performance Exercise Items

Exercise Number	Exercise Description	TCS Number(s)	Content Validity Ratio
1.	Drill Sharpening	78	.2
2.	Interpretation of Coarse Measurements	100	.6
3.	Angle Iron Clip Fabrication	58	.6
4.	Blind Hole Drilling & Tapping with Fabrication of a Threaded Rod to fit	71,74	1.0
5.	Identification of Fasteners	65	.6
6.	Solder Joint Assembly	40	1.0
7.	Manual Gasket Fabrication	66,75	1.0
8.	Valve Inspection (Gate & Globe) with Data Return	19,21	.6
9.	Trap Inspection (Steam & Air) with Data Return	18	0

Table 4

Representativeness of Course Content

TCS Content Domain	Job Content Domain Weight	Course Content Domain Weight	Discrepancy
Welding, Burning and Cutting	7.5%	20.2%	+12.7%
Rigging and Hoisting	6.7%	3.4%	-3.3%
General Mechanic Work	9.2%	8.3%	- .9%
Insulation	1.7%	0.0%	-1.7%
Equipment Lubrication	2.5%	2.4%	- .1%
Plumbing and Pipe Fitting	9.2%	6.1%	-3.1%
Equipment Operation	1.7%	0.0%	-1.7%
General Safety	6.7%	.7%	-6.0%
Basic Hand and Power Tools	11.7%	5.1%	-6.6%
Machine Shop	8.3%	18.0%	+9.7%
Painting	2.5%	0.0%	-2.5%
Electrical Theory and Operations	14.2%	28.8%	+14.6%
Precision and Coarse Measurement	18.3%	6.8%	-11.5%